

環境研究総合推進費SII-6セミナー「水銀に関する水俣条約の有効性を考える」

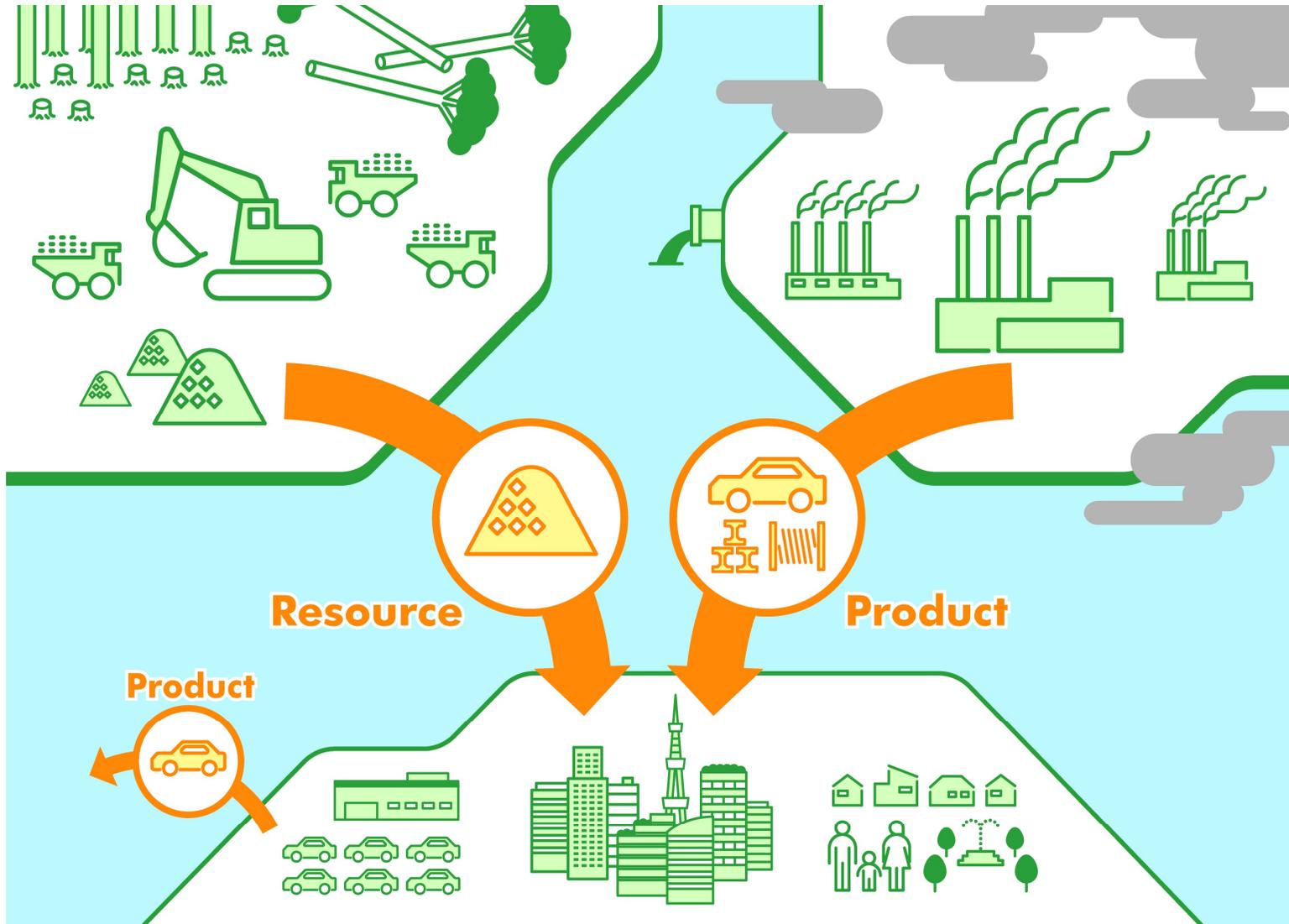
日時：2022年9月8日

水銀の使用と貿易

国立環境研究所 資源循環領域

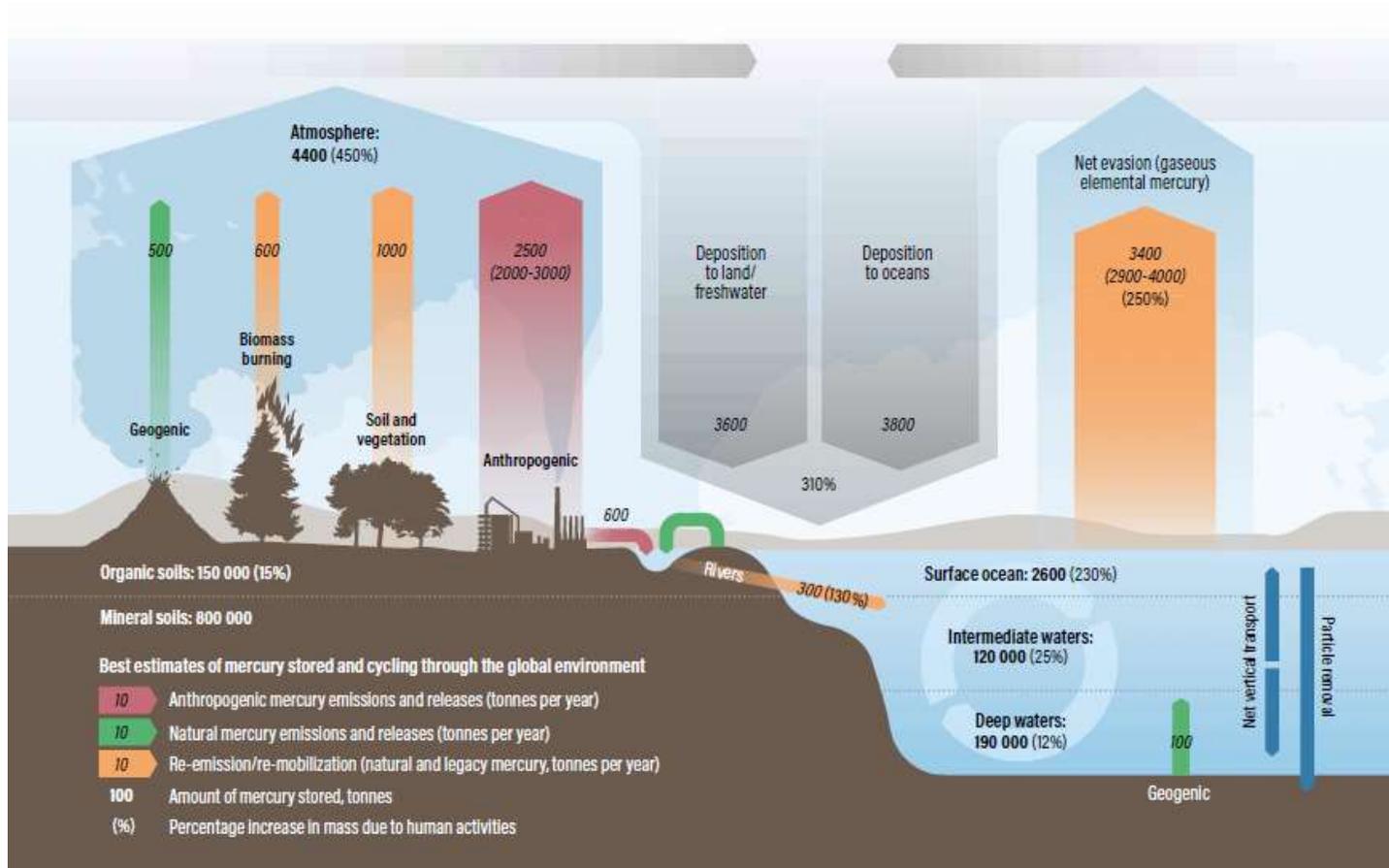
中島謙一

SII-6-2, 有効性評価に資するシナリオ分析モデルの開発(JPMEERF20S20620)



地球規模の水銀循環

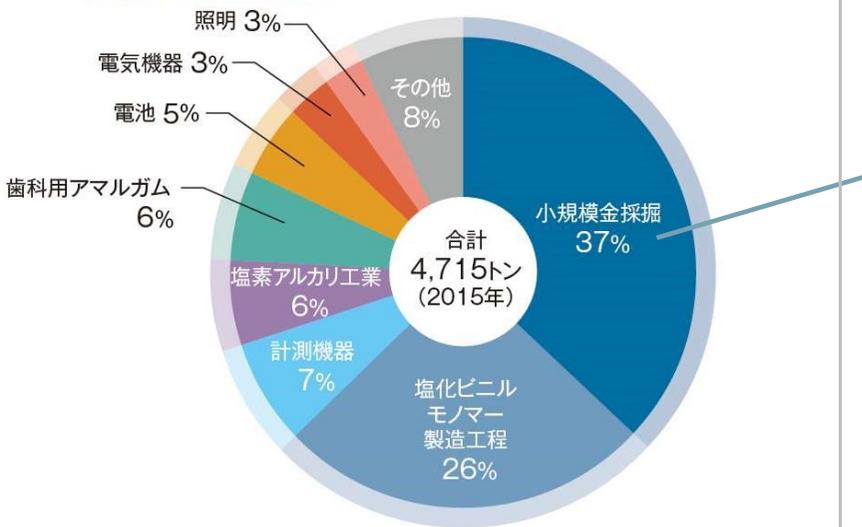
人為的な水銀の大気排出: 2000-3000トン、放出: 600トン



人間活動と水銀： 需要と排出

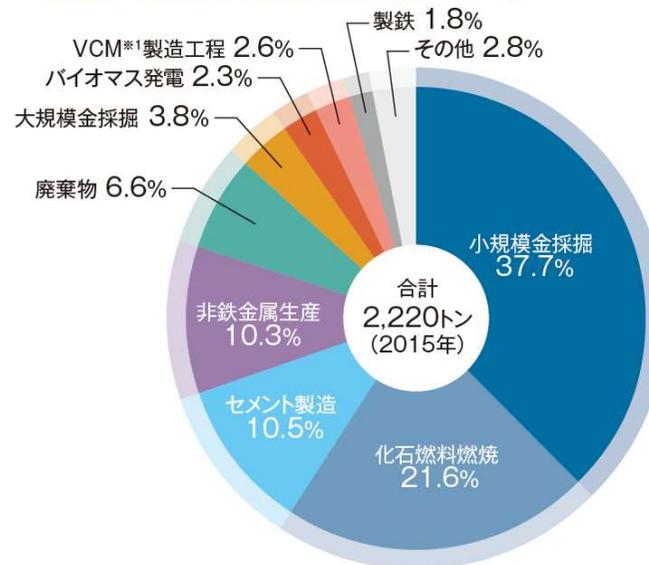
水銀の需要量

■ 世界の水銀需要量

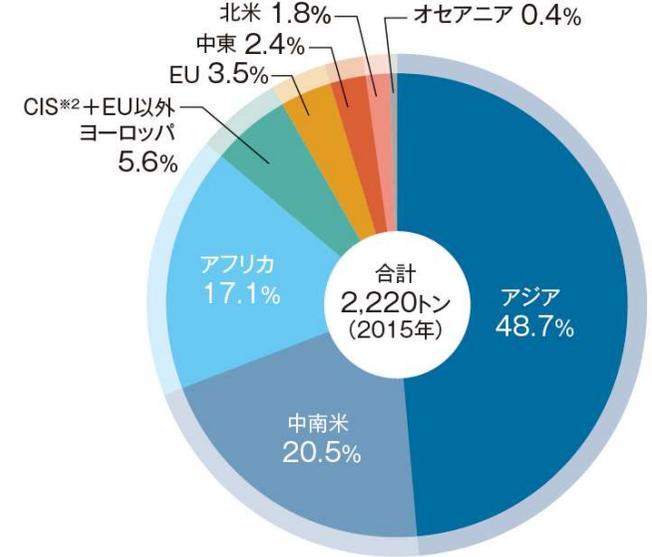


水銀の排出量

■ 排出源ごとの大気排出量 (2015年)



■ 世界各地域の大気排出量 (2015年)



※1 塩化ビニルモノマー

※2 The Commonwealth of Independent States (独立国家共同体)

出典：UNEP Global mercury supply, trade and demand (2017)

出典：UNEP Global Mercury Assessment 2018 (2019) より

「水銀に関する水俣条約」と有効性評価

水銀に関する水俣条約

第二十二條有効性の評価

1 締約国会議は、この条約の効力発生の日から六年以内に及びその後は締約国会議が決定する間隔で定期的に、この条約の有効性を評価する。

3 評価は、次のものを含む利用可能な科学、環境、技術、資金及び経済に関する情報に基づいて実施される。

(a) 2の規定により締約国会議に提供される報告その他の監視に基づく情報

(b) 前条の規定により提供される報告

(c) 第十五条の規定に従って提供される情報及び勧告

(d) この条約に基づいて設ける資金援助、技術移転及び能力形成の取決めを運用することについての報告

求められる有効性評価と手法開発



UNEP/MC/COP.3/14

Table 1
Effectiveness evaluation framework, from the policy questions and indicators to the required reports for the Effectiveness Evaluation Committee

Policy questions	1. Have the parties taken actions to implement the Minamata Convention?	2. Have these actions resulted in changes in supply, use, emissions and releases of mercury into the environment?	3. Have these changes resulted in changes in levels of mercury in the environment, biotic media and vulnerable populations that can be attributed to the Minamata Convention?	4. To what extent are existing measures under the Minamata Convention meeting its objective of protecting human health and the environment from mercury?
Indicators	Process indicators	Outcome indicators Monitoring indicators	Monitoring indicators	Level 5
Indicator clusters	1. Supply cluster (B) 2. Demand cluster (C) 3. Pressure cluster (D) ---- 4. Support cluster (E) 5. Information and research cluster (H)	1. Supply cluster (B) 2. Demand cluster (C) 3. Pressure cluster (D) ---- 4. Support cluster (E) 5. Information and research cluster (H)	1. Pressure cluster (D)	The Effectiveness Evaluation Committee will respond to these policy questions and use an integrative approach to prepare its findings based on the following synthesis reports: 1. Article 21 synthesis report 2. Emissions and releases report 3. Trade, supply and demand report 4. Waste report 5. Monitoring report
Information sources	Parties: Article 21 reports (main source)	Parties: article 21 reports (main source)	Parties: article 21 reports Monitoring networks	4. Waste report 5. Monitoring report
Secretariat documents for the Conference of the Parties, in accordance with article 22	- Report on article 21 reports - Report of the Implementation and Compliance Committee (article 13) - Reports on capacity-building, technical assistance and technology transfer (article 14)	- Report on article 21 reports	Not applicable	The above information will be supplemented by the attribution report when available. In formulating its findings, the Effectiveness Evaluation Committee may also draw on additional information as required.
Reports to be prepared for the Effectiveness Evaluation Committee	Levels 1-3 1. Article 21 synthesis report on progress made by parties in fulfilling their obligations under the Minamata Convention (corresponding indicators in article 21 reports) 2. Report on emissions and releases of mercury into the environment (pressure cluster) 3. Report on trade in, the supply of and demand for mercury in the economy (supply and demand cluster) "Economic movement of mercury" 4. Waste report (supply and demand cluster, pressure clusters) "Mercury remaining in the economy"		Level 3 5. Monitoring report	↓
			Level 4 6. Attribution report	
Outcome	The Conference of the Parties will consider the findings of the Effectiveness Evaluation Committee on the four policy questions.			Level 6

既往研究： 経済活動と水銀と健康影響のモデリング

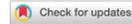
繋がり (人為的活動-排出-環境動態-人健康影響) に着目したモデル研究



ARTICLE

<https://doi.org/10.1038/s41467-021-23391-7>

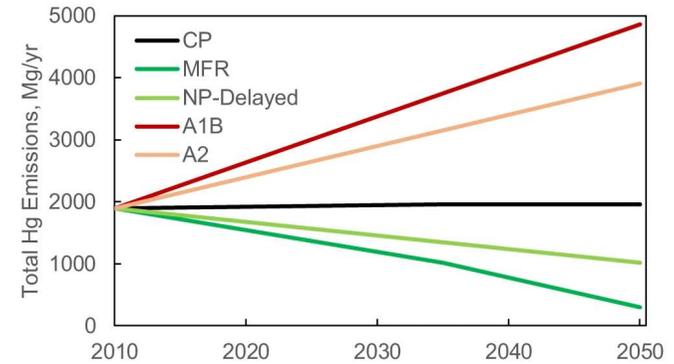
OPEN



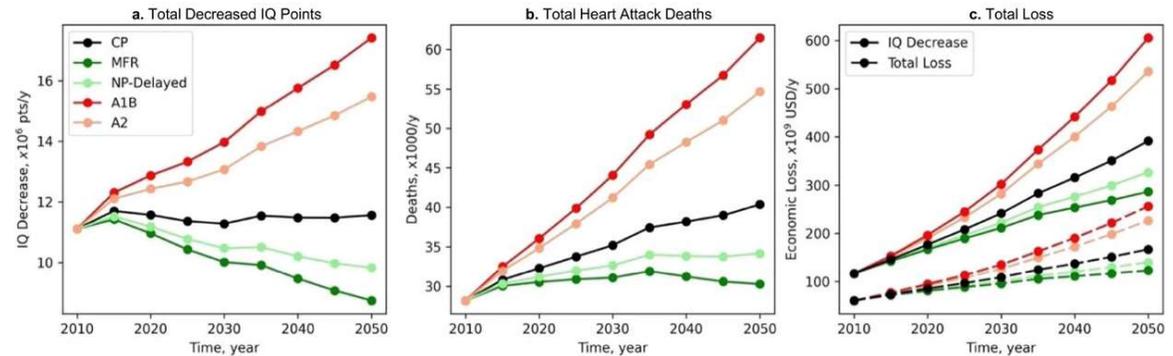
Global health effects of future atmospheric mercury emissions

Yanxu Zhang¹, Zhengcheng Song¹, Shaojian Huang¹, Peng Zhang¹, Yiming Peng¹, Peipei Wu¹, Jing Gu¹, Stephanie Dutkiewicz², Huanxin Zhang^{3,4}, Shiliang Wu^{4,5}, Feiyue Wang⁶, Long Chen⁷, Shuxiao Wang^{8,9} & Ping Li¹⁰

Mercury is a potent neurotoxin that poses health risks to the global population. Anthropogenic mercury emissions to the atmosphere are projected to decrease in the future due to enhanced policy efforts such as the Minamata Convention, a legally-binding international treaty entered into force in 2017. Here, we report the development of a comprehensive climate-atmosphere-land-ocean-ecosystem and exposure-risk model framework for mercury and its application to project the health effects of future atmospheric emissions. Our results show that the accumulated health effects associated with mercury exposure during 2010-2050 are \$19 (95% confidence interval: 4.7-54) trillion (2020 USD) realized to 2050 (3% discount rate) for the current policy scenario. Our results suggest a substantial increase in global human health cost if emission reduction actions are delayed. This comprehensive modeling approach provides a much-needed tool to help parties to evaluate the effectiveness of Hg emission controls as required by the Minamata Convention.



CP (current policy) scenario assumes a near to constant emissions through 2050. A1B and A2 are for business as usual and a divided world scenarios with increasing emissions, respectively. MFR (maximum feasible reduction) assumes the application of the best available technologies and aggressive emission reductions. NP-Delayed (new policy delayed) assumes the 2035 goal of the MFR scenario is delayed to 2050.



(a) Total intelligence quotient (IQ) decrements of newborns; (b) Total heart attack deaths; (c) Economic valuation of health effects: total valuation (solid lines) and from IQ decrements (dashed lines). Five scenarios are included: A1B (business as usual), A2 (divided world scenario), CP (current policy), NP-Delayed (new policy delayed), and MFR (maximum feasible reduction).

既往研究： グローバルスケールでの人為的な水銀排出量の推計

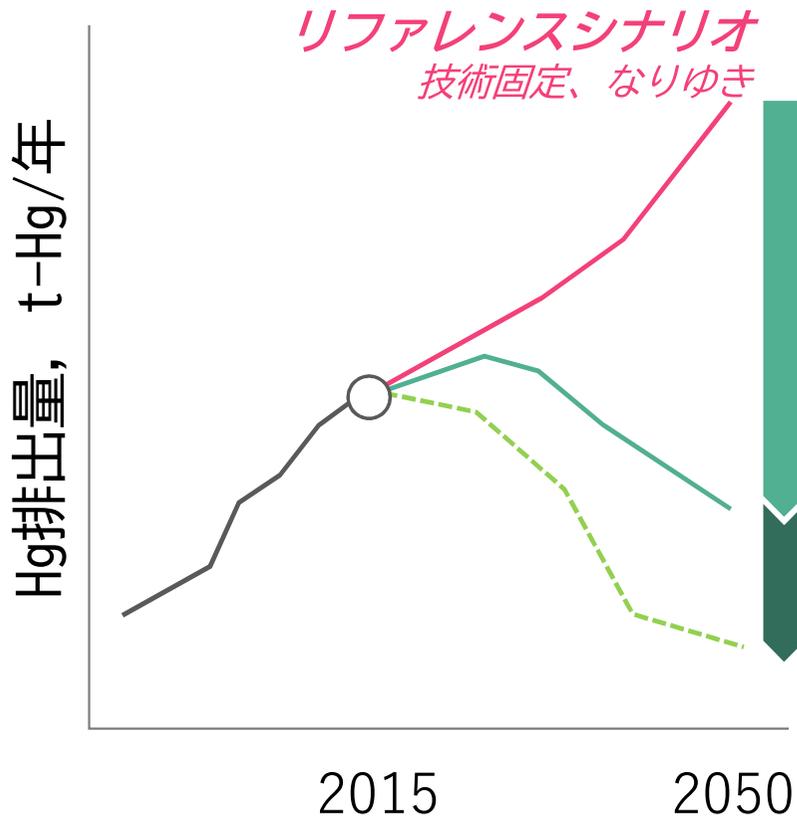
Zhang 2021, Global health effects of future atmospheric mercury emissionsでも活用

	Streets 2017	Li 2017	Rafaj 2013	Streets 2009	Pacyna 2010
排出源	主要排出源	鉱業	主要排出源	燃烧・鉱業	主要排出源
空間解像度	全世界 7地域区分	全世界・ 186国・地域	全世界・ 8地域区分	全世界・ 17地域区分	全世界・ 7地域区分
対象年次	1850-2010	2010	2000-2050	1996,2006, 2050	2005, 2020
将来シナリオ	-	-	気候変動対策(POLES)	気候変動対策(SRES)	水銀対策(LRTAP)

- 2°C目標と合致した気候変動対策の進展・強化
- 鉱物資源の急速な需要拡大
意図的水銀利用：ASGMなど
非意図的水銀利用：石炭燃焼、鉄鋼、セメントなど

気候変動対策と水俣条約の対策の双方の考慮
社会変化の拡充・精査と空間解像度の向上

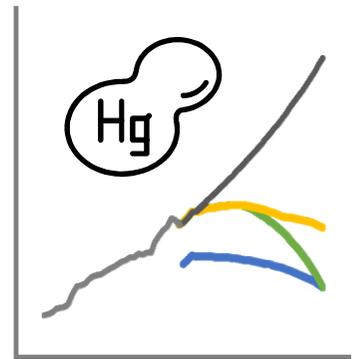
SII-6の視点： 水銀対策と脱炭素対策（共便益）の削減効果



削減対策シナリオ

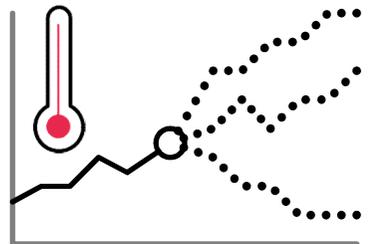
水銀対策による削減（3種）

- ・ 段階的削減
(orエキスパートジャッジ)
- ・ 最大削減_20XX年達成
- ・ 究極的削減

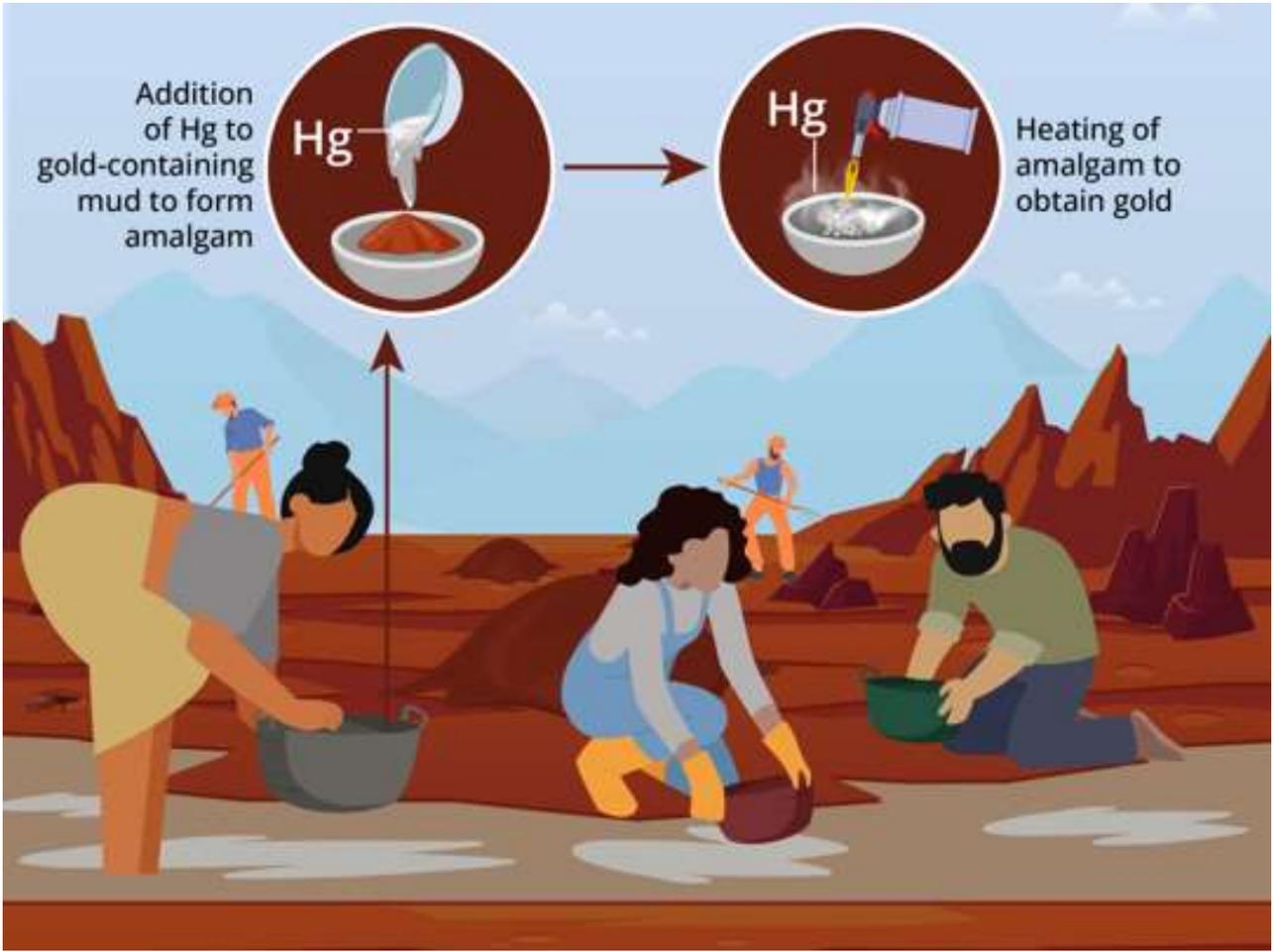


脱炭素対策による削減（2種）

- ・ 2°C目標整合
- ・ 1.5°C目標対応



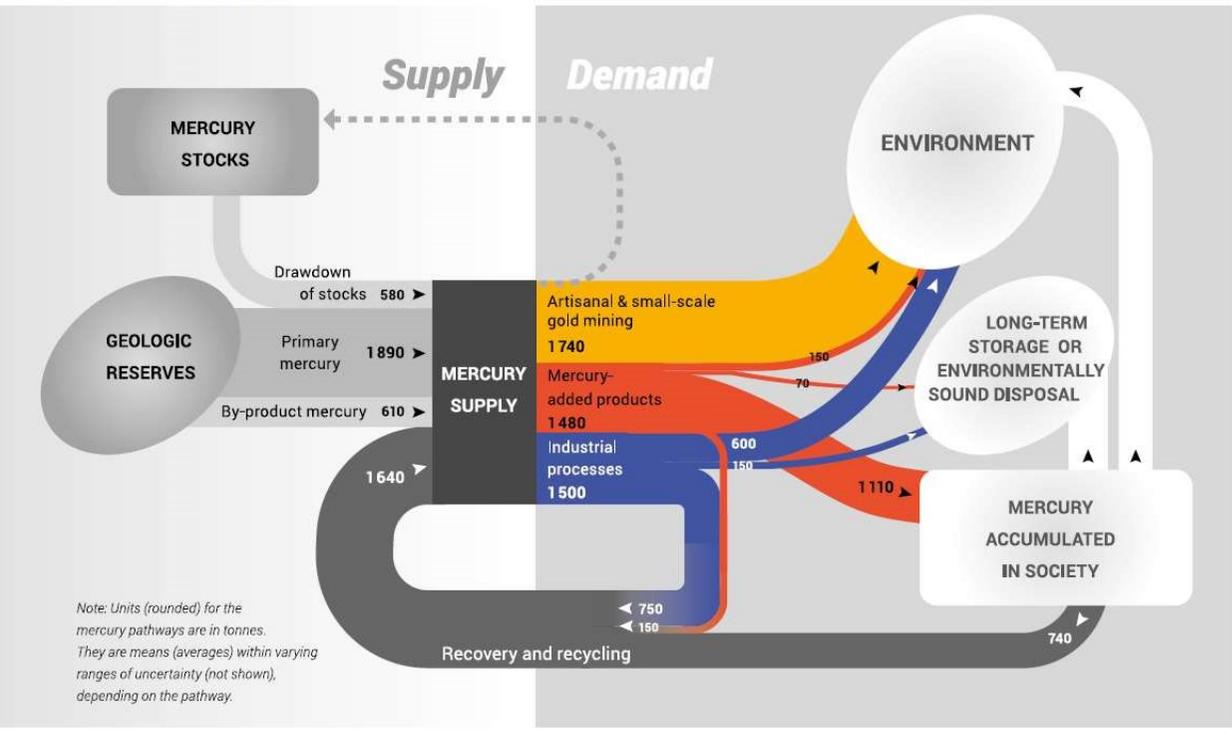
ASGM(零細・小規模金採掘)と水銀汚染



左図: UN Environment, Artisanal and Small Scale Gold Mining – Facts and Figures, <https://mercury.unitar.org/site/document/1272>

グローバルな水銀需給と水俣条約

Global mercury supply and demand, 2015



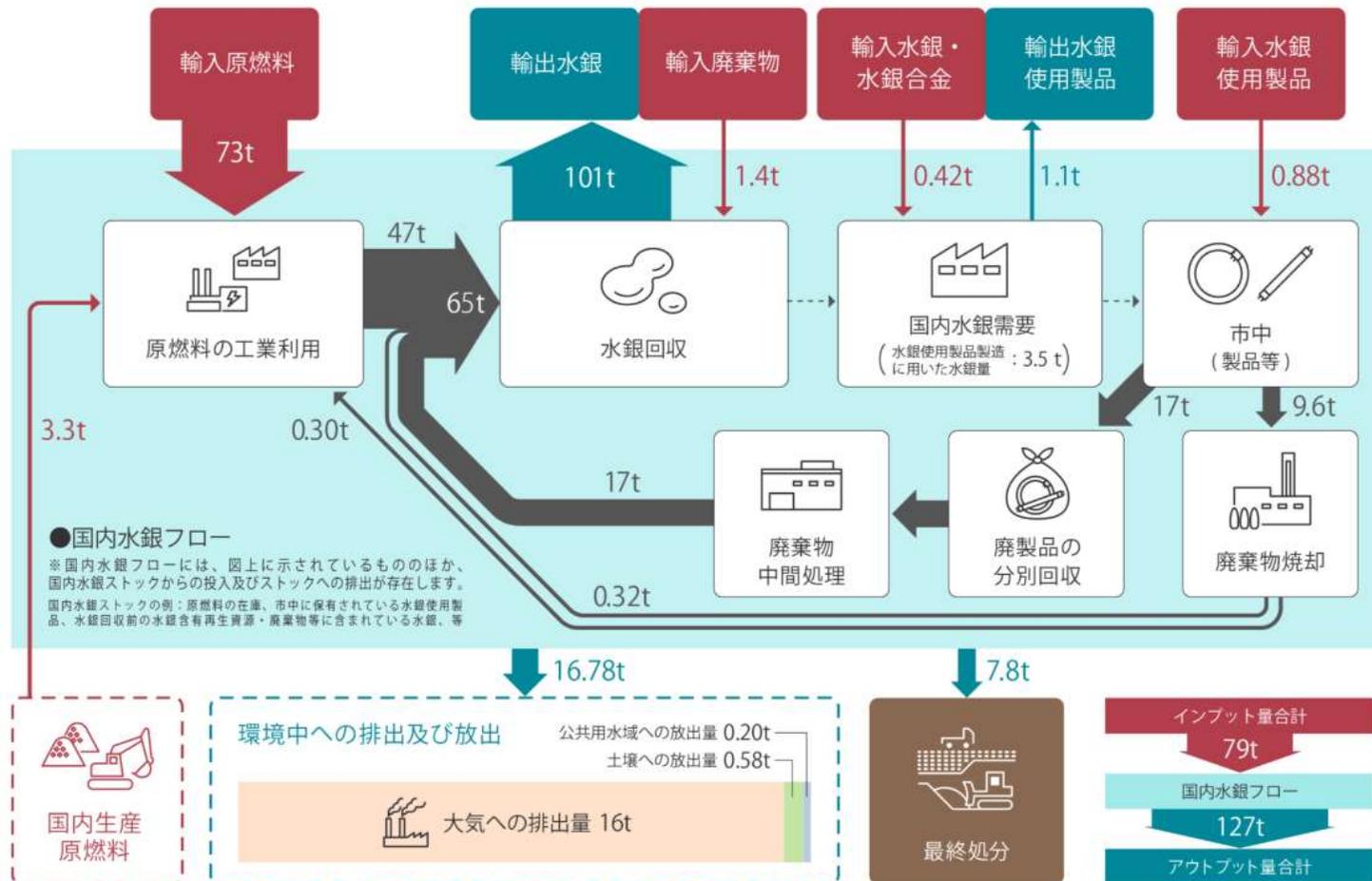
意図的な水銀フローの例

- 零細・小規模金採掘 (ASGM)
- 工業利用 (塩素アルカリ製造、塩ビモノマー製造)
- 水銀添加製品製造など

非意図的な水銀フローの例

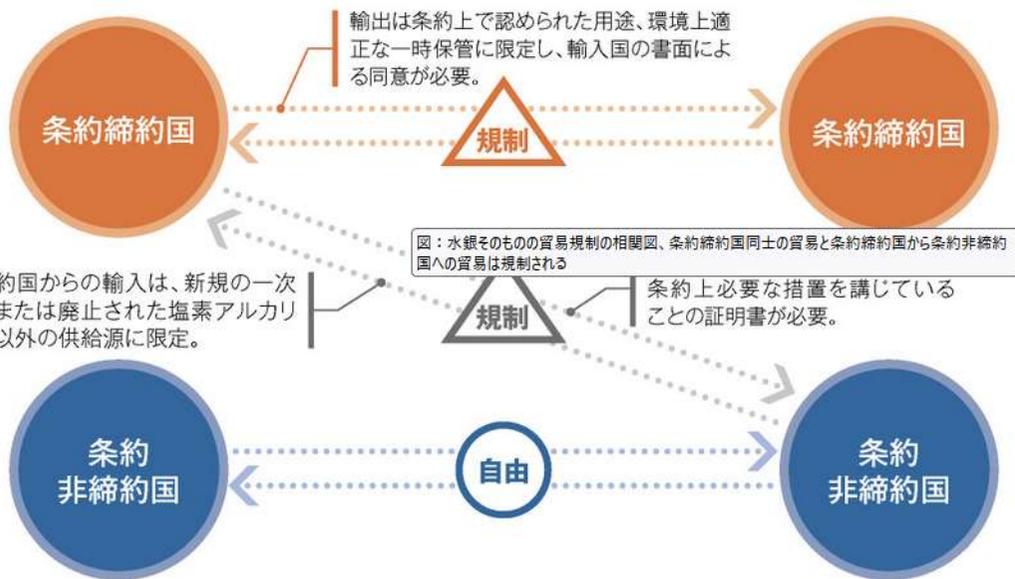
- 石炭等の燃焼 (火力発電など)
- セメント製造、金属製錬
- 廃棄物焼却など

我が国の水銀に関するマテリアルフロー（2016年）

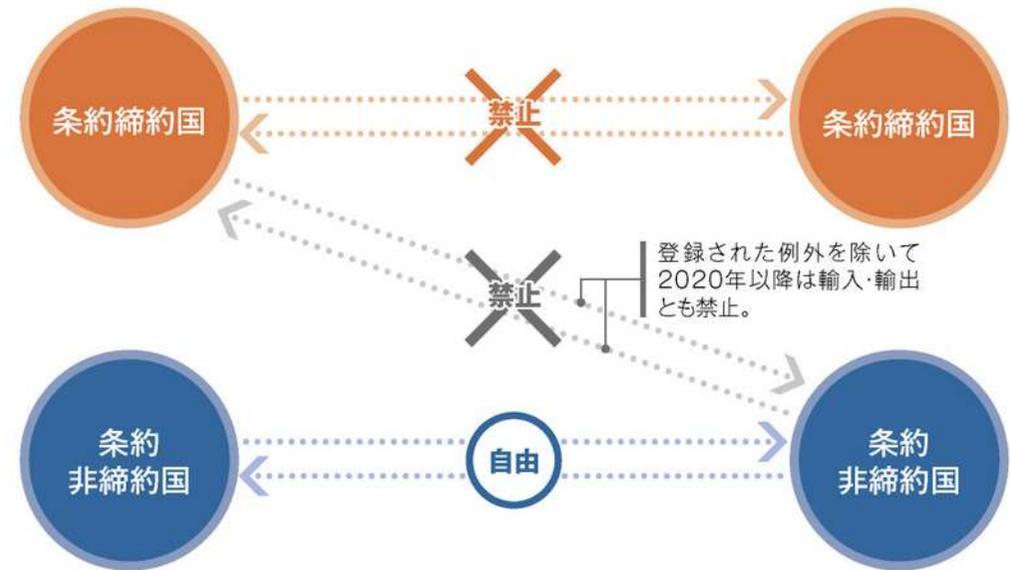


貿易規制：輸出された水銀の不法な流用を廃絶するために

水銀そのものの貿易規制

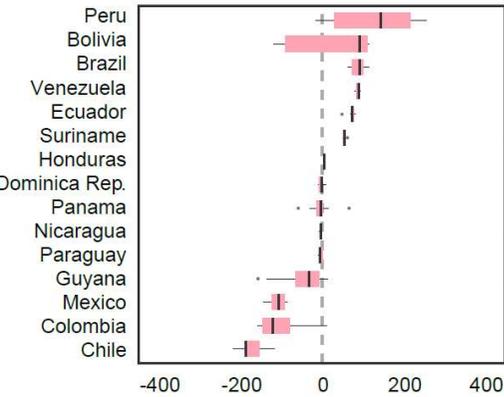


水銀添加製品の貿易規制 (禁止された製品について、2020年以降)

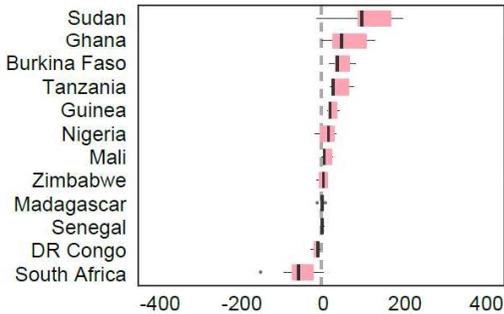


ASGM実施国を介した不適切な水銀フローの検出方法の開発を目指して

Central & South America



Africa

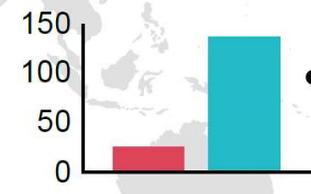
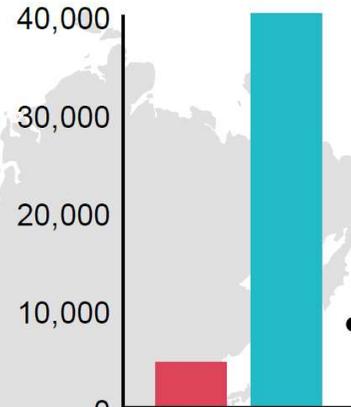
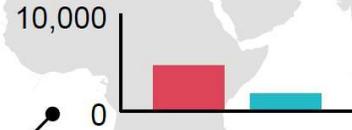
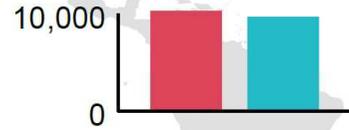


ASGM Hg input

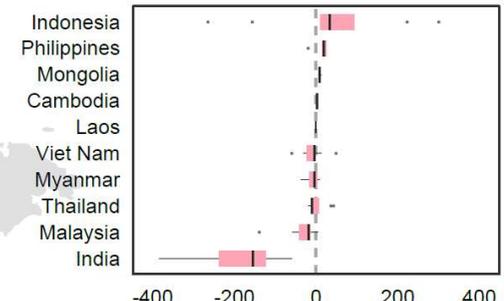


Apparent Hg consumption

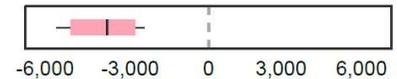
(tonnes)



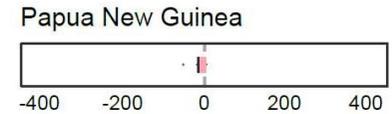
Asia (except China)



China



Oceania



Gap between ASGM Hg input and apparent Hg consumption from 2010 to 2018 (tonnes)

Partner Events of EcoBalance 2022

Mercury Legacy in Artisanal and Small-Scale Gold Mining

FREE
EVENT!

Date

October 30, 2022

Venue

Fukuoka Convention Center,
Fukuoka, Japan

Contact

ecobalance@ilcaj.org



[https://www.ecobalanceconference.org/
conference/2022/index.html](https://www.ecobalanceconference.org/conference/2022/index.html)



Organized by Material Cycles Division, National Institute for Environmental Studies
Co-organized by Graduate School of Environmental Studies, Tohoku University

Speakers and Topics

Inconsistencies of mercury flow in global trade concerning artisanal and small-scale gold mining activity

Yingchao Cheng National Institute for Environmental Studies

Exploring illegal trade of mercury from discrepancy with trade statistics

Masaaki Fuse Hiroshima University

Monitoring Artisanal and Small-Scale Gold Mining using Satellite Images

Kazuyo Hirose Japan Space Systems

Tailings management as a key challenge to curb mercury dissemination in and around ASGM sites

Satoshi Murao Daiichi Institute of Technology

Human health risk assessment of mercury vapor around ASGM area - perspective from field measurement

Koyomi Nakazawa Toyama Prefectural University

Mercury mitigation in artisanal and small-scale gold mining: cyanide emissions and the need for retorted mercury management as unintended consequences

Shoki Kosai Ritsumeikan University

Novel refining procedure of gold in ASGM and the hurdle of its spreading

Akihiro Yoshimura Chiba University

ご清聴ありがとうございました。

SII-6-2, 有効性評価に資するシナリオ分析モデルの開発(JPMEERF20S20620)